Early Journal Content on JSTOR, Free to Anyone in the World

This article is one of nearly 500,000 scholarly works digitized and made freely available to everyone in the world by JSTOR.

Known as the Early Journal Content, this set of works include research articles, news, letters, and other writings published in more than 200 of the oldest leading academic journals. The works date from the mid-seventeenth to the early twentieth centuries.

We encourage people to read and share the Early Journal Content openly and to tell others that this resource exists. People may post this content online or redistribute in any way for non-commercial purposes.

Read more about Early Journal Content at http://about.jstor.org/participate-jstor/individuals/early-journal-content.

JSTOR is a digital library of academic journals, books, and primary source objects. JSTOR helps people discover, use, and build upon a wide range of content through a powerful research and teaching platform, and preserves this content for future generations. JSTOR is part of ITHAKA, a not-for-profit organization that also includes Ithaka S+R and Portico. For more information about JSTOR, please contact support@jstor.org.

ON CLINTON CONGLOMERATES AND WAVE MARKS IN OHIO AND KENTUCKY.

WITH A RÉSUMÉ OF OUR KNOWLEDGE OF SIMILAR OCCURRENCES IN OTHER SILURIAN STRATA OF THESE STATES, AND THEIR EVIDENCE UPON PROBABLE LAND CONDITIONS.

CONTENTS.

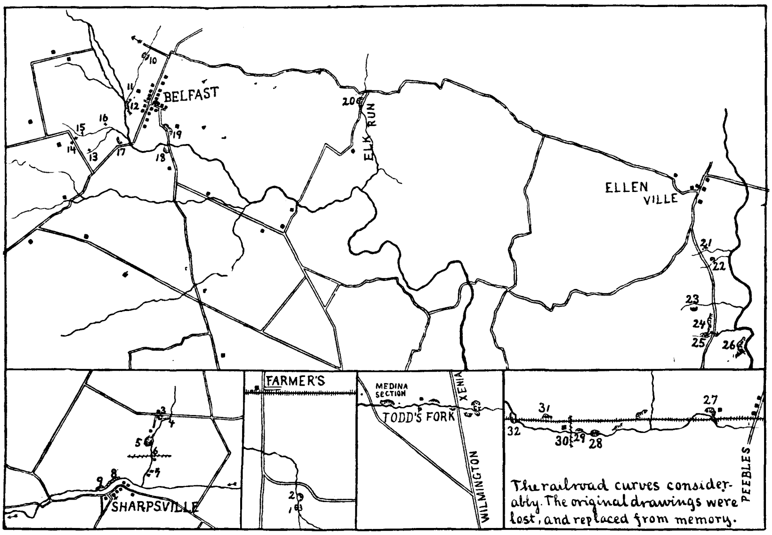
- First record of the occurrence of pebbles in the Clinton of Ohio, by Professor Orton.
  - Former observations by the writer, based upon Professor Orton's material.
- Pebbles and wave marks in the Cincinnati group.
  - Observations by the Kentucky Survey.
    - Trenton.
    - Utica, or "Lower Hudson" of Kentucky Survey.
    - "Middle" Hudson.
    - "Upper" Hudson.
  - Observations by Mr. E. O. Ulrich, in Kentucky.
    - Lower Hudson; West Covington; Middle and Upper Hudson.
  - Observations by Professor John Locke, in Ohio.
    - Upper Hudson, near West Union.
  - Observations by Professor E. Orton, in Ohio.
    - Lower Hudson, near Cincinnati.
  - Observations by the writer.
    - Lower Hudson, at West Covington, Kentucky.
    - Upper Hudson, near Winchester, Ohio.
  - Observations by Nelson W. Perry and Joseph F. James, near Oxford, Ohio.

First record of the occurrence of pebbles in the Clinton of Ohio, by Professor Orton.—It is almost twenty-five years since the discovery of pebbles in the Clinton of Ohio was announced. The value of the discovery for determining the physical conditions which must have attended the deposition of this group was at once recognized. The Cincinnati anticlinal axis was believed to have been in existence as a land area in Paleozoic times, and the occurrence of pebbles towards the eastern border of the axis, the supposed shore line of Paleozoic times, seemed strong corroborative evidence of this view, and was believed to fix the date of the initial rise of the axis, at least approximately. Curiously enough, in spite of the acknowledged importance of the discovery, Professor Edward Orton, the discoverer, and the now venerable state geologist of Ohio, seems to be the only geologist who ever visited the original pebble locality at Belfast, in Highland county, and so all references to the pebbles made by other writers are based upon his work. For that reason his original statement, made in the report of the Ohio Geological Survey for 1870, page 270, is here reprinted. Those parts of the quotation which recent discoveries seem to disprove are italicized:

> "A bed of limestone conglomerate, several feet in thickness, occurs near the *base* of the (Clinton) series in the southern part of the county. But a single exposure of the conglomerate has yet been noted. This is found one mile due west of Belfast, on the Belfast and Fairfax road, on the land of Charles Dalyrymple (localities 13, 14, and 15, of this paper).
>
> "The pebbles that compose the conglomerate *appear to have been derived from the Blue limestone or Cincinnati rocks.* The conglomerate is also fossiliferous, well-worn forms of ancient life being incorporated with it. The fossils can be referred *either to the Cincinnati or* Clinton group, as they consist of forms that are common to both formations, viz., cyathophylloid corals of the genus Streptelasma and the remarkable fossil, Orthis lynx—a bivalve shell of immense vertical range, as is shown by its occurrence in the Trenton, Hudson (Cincinnati), Clinton, and Niagara limestones of the Lower and Upper Silurian ages, successively. It seems more probable, however, that the fossils in question were derived from Clinton seas rather than from the waste of rocks of a previous age.
>
> "The occurrence of this conglomerate attests the existence of land near by—the shores of which were wasted by the sea, and the water-worn and rounded fragments of which were re-deposited on the floor of the sea. Since the first systematic study of the geology of the Mississippi Valley, proofs have been accumulating that a Silurian island stretched northeastward from Nashville, towards and beyond Cincinnati. Highland county furnishes its full quota of facts as to the existence, and as to certain of the boundaries of this ancient land. Other facts will be adduced that bear upon this point in the description of the remaining formations of the county. The date of the uplift of this island is approximately determined by the fact already quoted—as land at the westward is found in existence *early in the history of the Clinton.* This folding of the crust, then, that transformed a portion of the ancient sea bottom into dry land, probably occurred about the close of the Lower Silurian

time, and it seems also safe to say that it not only marks the date but *furnishes the producing cause of the change in the formation that then took place.* The Medina shales may be referred to sediments that settled in seas, disturbed by igneous agencies—the long continued life of the preceding periods being exterminated in this region by the shallowing waters, as the low mountain chain emerges."

The change in formation, to which reference is made above, is that from the alternating limestones and clays of the Cincinnati group to the shales of the Medina. Volcanic disturbances sufficient to keep the sediment of the sea in commotion, are hardly necessary to account for the change in the lithological character of the two formations.



The railroad curves considerably. The original drawings were lost, and replaced from memory.

Sketch maps of localities referred to in this article.

Former observations by the writer, based upon Professor Orton's material.—Some years ago Professor Orton kindly placed at the disposal of the writer the pieces of conglomerate which had come from the original locality near Belfast. At that time it was noticed that the fossils contained in the cement among the pebbles were all of Clinton age, and not a single species of Cincinnati group affinities was found. Even in the case of Orthis lynx it was the Clinton form, and not one of the Cincinnati group forms, which had been found. The pebbles of the conglomerate fragments collected by Professor Orton, were unfossiliferous, though fossils have been found recently, as described below. The lithological appearance of the pebbles was unlike that of any of the limestones known from the upper part of the Cincinnati group in Ohio.

It seemed therefore that some of the statements made in the original publication needed re-investigation, before they could be considered a safe basis for conclusions as to the probable physical and geographical conditions which obtained in Clinton times. A week was therefore spent in Clinton, Highland, and Adams counties, and sufficient material was found to disprove some of the original statements and to shed quite an additional amount of light upon the problems involved.

The original material is given in the following pages in full. Abstracts of pertinent observations made by other writers are also presented. Those who are more interested in the conclusions at which we have arrived, than in the facts upon which the conclusions are based, will find the former concisely presented at the end of this article.

PEBBLES AND WAVE MARKS IN THE CINCINNATI GROUP.

Observations of the Kentucky Survey.—In order to understand the physical conditions which prevailed during the Clinton epoch in Ohio, it is necessary to study this problem in connection with conditions existing both before and after this epoch. Since the central counties of Kentucky are also involved in the Cincinnati anticlinal axis, any facts which they afford will also be of interest. The following facts are collated from the more recently published reports on the geology of the various counties. With the exception of the report on Marion county, by W. T. Knott, and that on Clinton county, by R. H. Loughridge, these reports are all from the pen of W. M. Linney.

Trenton.—In Garrard county some of the layers are very irregular in their bedding, and some show wave marks. In Clark county the irregular stratification sometimes amounts to cross-stratification, and at one locality great wave marks are found. Near the top of the Trenton are often seen rounded pebbles of limestone distributed in thin beds for a number of miles. They are mentioned from Garrard, and also from Clark and Montgomery counties.

Lower Hudson.—These beds are considered by Mr. E. O. Ulrich as being in large part equivalent to the Utica. Mention of wave marks is made from the following counties: Shelby, Spencer, Washington, Marion, Mercer, Garrard, Madison, Clark, Montgomery, Bath, Fleming, and Mason. The wave marks occur in the upper beds of this division. In Mercer county they are stated to occur 140 to 170 feet above the base. Their occurrence in the *upper* beds is more or less directly inferred from statements made with reference to these layers in Spencer, Washington, Mercer, Garrard, Madison, Bath, and Mason counties, and this is presumably their horizon also in the other counties. Cross-stratification occurs in the upper beds in Mason county.

Rounded limestone pebbles are stated to occur only in the case of one county, Washington. Here the lowest layer of the Lower Hudson is said to be about one foot in thickness, and to contain usually some rounded limestone pebbles. The occurrence of pebbles in Clark and Montgomery counties seems to be warranted by the following statement made, under the title of "Disturbances in Clark and Montgomery," in one of the reports: "In the Lower Hudson beds, where the alternations of hard limestones and shales are so constant, the intervals were produced by corresponding changes of condition, and in these hard layers are sometimes seen large pebbles of limestone, which have been worn until half round and then consolidated with finer material." In this case no particular horizon is mentioned.

Middle Hudson.—Wave marks are mentioned from Nelson, Washington, and Mason counties. In Washington county they are said to occur at the base. Those from Mason county are not located, and the reference to them is suspicious, as though the wave marks belonged to the well-known waved beds of the

Lower or possibly even the Upper Hudson, rather than the Middle division, under which the reference happens to occur.

Upper Hudson.—Cross-stratification occurs in the lower beds in Clark county; it is said sometimes to resemble large wave marks. The same conditions seem to occur also in Montgomery county. Wave marks occur in Oldham, Lincoln, and Fleming counties. Their position in Oldham seems to be somewhere beneath the top; in Lincoln they are found at many horizons; in Fleming they are located near the top of the series. In Spencer county indurated clay balls are found in the earthy limestones and shales near the top of the Upper Hudson. Under "Disturbances in Clark and Montgomery Counties" rounded pebbles of limestone are said to occur in some of the strata of the Upper Hudson.

Observations by E. O. Ulrich.[1]—At the base of the Lower Hudson there is generally a layer of limestone, one foot or so in thickness, which usually contains some rounded limestone pebbles. No localities are given, but Mercer, Boyle, and Washington counties are mentioned in the preceding sentence, and the occurrence of these features here and in other counties of central Kentucky may be inferred. See, for instance, the reference to a similar layer at the same horizon in Washington county, given above from the Kentucky Survey. In West Covington opposite Cincinnati, and about a mile west of the mouth of the Licking, the conglomerate occurs, which is to be more fully described, just below, from personal observations made in company with Mr. Ulrich. This locality belongs to the Lower Hudson, or the Utica of Ulrich. It is described by Professor N. S. Shaler in one of the earlier reports of the Kentucky Geological Survey. The waved-layers, which occur at several localities near Cincinnati, are correlated with the wave-marked layers so frequent near the top of the Lower Hudson in the other counties of Kentucky (Am. Geol., 1888, page 314).

In Washington, Boyle, Lincoln, Garrard, Madison, and Clark counties, the strata belonging to the top of the Middle Hudson and the bottom of the Upper Hudson are decidedly arenaceous, this feature being much more pronounced and of greater extent in southern Kentucky than in Ohio and Indiana. In fact, some of the lower portions of this series may with truth be called sandstones.

---

[1] American Geologist, 1888, May, pages 308–310.

Observations of Dr. John Locke at West Union; Upper Hudson.—The locality is twelve miles a little east of south of Elk Horn creek, near a house known as Treber's at the time of Locke's report (Geol. Surv. Ohio, 1838, p. 246, and plate 6), in the bed of Lick Run. It is about four miles northeast of West Union, as nearly as can be determined from the report. Here, about fifty-five feet below the level of the Clinton, for a distance of 400 feet, wave marks occur in the upper Cincinnati group beds, with crests two to three feet apart, and two to three inches above the troughs. According to Locke they may be traced at about the same horizon for miles.

Observations of Professor Orton.—In Vol. I. of the Ohio Survey report, page 377, Prof. Orton mentions that Locke noted the wave-marked layers in the upper beds of the Cincinnati group, and then states that they are even more characteristic of the lower beds (the Lower Hudson of Kentucky reports) as shown in the river quarries of Cincinnati, or in the 100 feet that are there exposed. These wave-marked layers are said in every case to be overlain by shales.

OBSERVATIONS BY THE WRITER.

West Covington, Kentucky (Lower Hudson, or Utica of Ulrich).—Opposite Cincinnati, halfway between the Chesapeake and Ohio and the Cincinnati Southern railway bridges, opposite house No. 31, along the road skirting the river front, nearly at the top of the section exposed along the Ohio river is a well stratified, sandy-looking limestone layer, in places almost two feet thick, which can readily be traced for a considerable distance along the river front. Over this lies a layer composed chiefly of coarse crinoidal remains but containing also many bryozoan fragments, and some brachiopods. The crinoidal layer is about twenty inches thick. Its chief interest consists in the fact that it evidently lies upon an eroded base, the underlying sandy-looking limestone having suffered more or less marked erosion previous to the deposition of the crinoidal layer. Owing to the marked stratification of the sandy limestone, the irregular erosion of its upper surface is readily observed, and the crinoidal layer is seen in places to descend considerably below the original level of the sandy layer. In some places the sandy limestone has been cut through so that the crinoidal bed rests upon the bed below the sandy limestone, but in the stretch examined along the river front the erosion seems to have been confined chiefly to the sandy layer and rarely extends to the layer beneath. Nothing could better express the limited vertical range of this erosion. In the crinoidal bed occur many fragments evidently derived from the sandy layer immediately beneath. Some of these fragments are of considerable width, slabs as long as two and a half feet having been seen inclosed in the crinoidal layer. The thickness of these fragments rarely exceeds four inches and is usually less. One slab of sandy limestone must have been at least five feet long, but this was exceptional. The usual length varies from four to seven, at times twelve inches, and the thickness varies from one to two inches. The edges are usually more or less rounded, but not to the same extent as are the pebbles of some of the Clinton conglomerates. Many of these pebbles occur near the base of the crinoidal layer; fewer are found in the central parts of this layer, but quite a number occur again, in places, at the top. It is very evident in this case, that the pebbles could not have been derived from a distant source, but must have been carried to pockets and depressions already formed in the sandy layer, while other parts of the same layer, at some point in the more immediate vicinity, were suffering erosion. Occasionally inclusions are found which were not derived from the sandy layer beneath. In one case, at least, a fragment of a coarsely crinoidal rock was included in the crinoidal layer; it was very similar to the inclosing rock, but its lines of stratification had a different angle. Rounded chunks of a clayey substance at present hardened, very fine-grained, and yellowish in color, also occur; in places, plentifully; almost always near the top of the crinoidal layer, rarely towards the middle, and never at the bottom. They evidently were derived from a slightly greater distance than the sandy pebbles, but similar clayey rocks occur abundantly just above the crinoidal layer in the present section, and it does not seem necessary to imagine derivation from any considerable distance, since rocks having this lithological character may have occurred at a lower horizon not far off. The top of the crinoidal layer occasionally shows a heaping up into ridges or wave marks. Wave marks are, however, more frequently and better shown in the layers just below the sandy bed. More frequently these wave marks are associated with irregular ripple marks making it impossible to determine the direction of the markings. In a general way they may be said to run slightly east of north, but the wave marks are hardly sufficiently well oriented or distinct to make it worth while to draw conclusions from the same. The crinoidal layer frequently shows bedding, and in that case, the stratification lines usually incline strongly to the west, giving rise to a sort of cross bedding, when seen in conjunction with the stratification planes above and below. After having studied this layer, it is easy to understand how the pebbles in the Cincinnati group at Elk Horn, east of Winchester, and in the various Clinton conglomerates, could readily have been derived from the layers immediately beneath.

Winchester (*Upper Hudson*).—Elk Horn creek is crossed by the Cincinnati, Portsmouth & Virginia railroad about a mile and a quarter east of Winchester. This region is about 10 miles west of Peebles, and 10 miles southwest of Belfast; it is 39 miles a little east of south from the Todd's Fork locality. The trestle crossing the creek is about 75 feet high. Down the creek from the bridge is a magnificent exposure of wave-marked Cincinnati rock. The highest hills around Winchester, and also in the direction of Elk Horn and Brush creeks, show Cincinnati rocks, so that this exposure must lie at least 60 feet beneath the level of the Clinton. The wave marks are exposed for several hundred feet along the bed of the creek below the bridge. The crests run north and south, are often three inches above the troughs, and are usually about 30 inches apart. Plenty of fossils occur just beneath the sand forming the wave ridges themselves, and they protrude through the same. On going down the stream lower horizons are met, and wave marks are also found at these lower levels. Farther down stream the wave marks run north 50° west and are not so fine as those first described. Still farther down stream are plenty of good pebbles caught up in the layers beneath the wave marks. The pebbles are often six, and occasionally eight and ten inches in diameter. They evidently were derived from the sandy, stratified, less fossiliferous beds of practically the same age which occur immediately beneath. While there was not found the same direct evidence of the derivation of these pebbles from other localities in the immediate vicinity, as opposite Cincinnati, this was probably due chiefly to less favorable exposure, those at Elk Run occurring chiefly in the creek bed, and those at West Covington being exposed on the steep banks of the Ohio in almost vertical section. While the pebbles were, as a rule, not richly fossiliferous, yet owing to their great abundance their identity could be readily established. All fossils found belonged to the horizon of the general matrix in which they were inclosed, showing their derivation from rocks of but slightly lower horizon.

Below the first house on the west side of the creek very good wave marks are again seen running north and south for a considerable distance. Farther down are others less good but distinct, running north 30° west. Within half a mile of the bridge, farther down, opposite a house on the east bank, plenty of pebbles occur in the rock. Some of these pebbles are slabs 16 inches in diameter, and about an inch to an inch and a-half thick. Just below, the wave marks run north 20° west. At a very considerable distance down the creek are loose slabs containing pebbles of moderate size, two to three inches in diameter. Farther down are poor wave marks, the usual distance apart and running north 45° east. Just below these are good wave marks running north 20° east. Some distance beyond this, Elk Horn creek enters into Brush creek. It will be noticed that the good wave marks were those running north and south or more nearly in this direction; those running more northeasterly or northwesterly were poor. This probably means that the strongest brunt of the waves and freest exposure to the sea lay directly westward at this point. Going up Brush creek, at a locality not far distant from the junction of the Elk Horn creek a layer showing wave marks was found. These were not recorded, but are believed from memory to have run north 30° west.

Observations by Nelson W. Perry and Joseph F. James.—Wave marks and raindrop impressions occur at Smiley's dam on Four-Mile creek, near Oxford, Ohio, at a level 600 feet above the Mt. Pleasant beds. On the Little Four-Mile creek, at Ridenour's Mills, wave marks occur, going up stream. Mud-cracks are found in Dearborn county, Indiana, 600 feet above the Mt. Pleasant beds. These occurrences probably belong therefore to the Upper Hudson of Kentucky geologists.

AUG. F. FOERSTE.

(To be continued.)